

# PATENT SPECIFICATION



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## PROVISIONAL SPECIFICATION

### Improvements in Electric Cable Couplings

We, ALEXANDER DALGETY FERGUSON, of San Isidro, Ashton Lane, Sale, in the County of Chester, a subject of the King of Great Britain, FREDERICK JOHAN HAMELBERG, of 24, Malpas Drive, Timperley, in the County of Chester, a subject of the King of Great Britain, and METROPOLITAN - VICKERS ELECTRICAL COMPANY, LIMITED, of Number One, 10 Kingsway, London, W.C.2, a British Company, do hereby declare the nature of this invention to be as follows:—

This invention relates to plug and socket couplings, for connecting ends of cable, in which one or more pins or plugs partially embedded, together with a cable end or a conductor or conductors emerging from the cable end, in moulded insulating material, is/are mated with a 15 corresponding socket or sockets embedded with another cable end, or a conductor or conductors emerging from the end thereof, in moulded insulating material. Usually the pins or plugs in such 20 couplings have a rounded or tapered forward portion, for facilitating entry into the co-operating socket, immediately followed by a portion, or neck, of substantially right figure intended for 25 making the desired electric contact with the forward end of the surrounding wall of the socket.

In the case of such couplings intended for use in connecting together ends of 30 cable required to carry ultra high frequency radio currents, it is especially desirable, from the point of view of maintaining constant surge impedance at the coupling, that especially good contact 35 should, at all times, be maintained between the neck of a plug and the forward end of the co-operating socket and that the insulating material surrounding the socket should at all times make intimate physical contact with the outer surface 40 of the socket, and the present invention is especially concerned with the achievement of these desirable objects.

It is apparent in such plug and socket 45 couplings that, if the socket wall be constructed so as to afford some degree of resilience, for instance by forming the socket with one or more saw-cuts or splits,

and the socket is mated with an over-size plug, relatively good electric contact is 55 possible. However, difficulty then arises in the choice of the mouldable insulating material in which the socket is to be embedded, since clearly the moulded material in which the socket is embedded 60 must allow of the aforesaid flexing of the socket wall. In the case of couplings for use with ultra high frequency radio cable, it is not permissible to provide clearance between the outside of the 65 socket and the surrounding insulating material; on the contrary, it is very important that the moulded insulating material should at all times be in close physical contact with the outer surface 70 of the socket, and this, too, whatever be the conditions of temperature if the coupling is to be satisfactory.

With the above considerations in view, according to the present invention the 75 socket member of a plug and socket coupling comprises one or more tubular parts having a bore conforming to the shape of, but somewhat less than the outside cross-section of, the plug pin or pins 80 of the mating member of the coupling which is/are intended to enter the socket(s) and having two or more slits in the wall thereof extending mainly in the axial direction of the socket, which 85 socket or sockets is/are embedded wholly, or mainly, in an insulating mass of material of low dielectric loss, such as a polymer of ethylene, with or without a plasticiser, for instance that known in 90 the trade as "Polythene", moulded around, and into close physical contact with, the outside of the socket or sockets and preferably also the cable end or a conductor or conductors emerging from 95 the cable end.

"Polythene" is especially desirable for the purpose in view in preference to the other more widely known and used mouldable insulating materials, by reason 100 of its low dielectric loss, great mechanical strength and especially good elasticity, even at temperature up to tropical atmospheric temperatures as well as below freezing point; moreover it has a 105 coefficient of thermal expansion con-

siderably greater than that of brass or other usual metal forming the socket or sockets, such coefficient for "polythene" being in fact of the order of  $260 \times 10^{-6}$  5 per degree Centigrade, as compared for example with a coefficient of  $80 \times 10^{-6}$  per degree Centigrade for one of the more usually employed mouldable insulating materials, namely vulcanite. In addition 10 to the fact that the mass of "Polythene" can be caused, by its excessive shrinkage, firmly to hold to the outside of the socket wall after moulding, yet be sufficiently resilient to follow the flexing 15 movement of the socket wall during repeated plugging in and out of the co-operating pin or pins, such close engagement between the embedding mass and the outside of the socket or sockets 20 can be maintained over excessively broad range of temperature.

It is contemplated that during manufacture of the socket member of the coupling, a plug of the same cross-section 25 as that of the socket, or possibly slightly less, will be inserted temporarily within the hole in the socket so that the socket will not collapse under the moulding pressure as it otherwise might do by 30 reason of its resilient nature, and also to prevent, as far as possible, extrusion of "Polythene" into the hole in the socket. Usually entry of "Polythene" into the 35 slits or saw cuts in the socket wall will not be detrimental, since the high shrinkage of the "Polythene" will be sufficient to provide the necessary clearance from the bore of the socket.

In a convenient embodiment of the 40 invention for coupling sections of a concentric cable carrying very high radio frequency currents, the plug member of the coupling comprises a cylindrical metal rod having a relatively long stem 45 portion of fairly large diameter for instance 0.2" in one practical application then a reduced portion or neck accurately cut to a predetermined diameter and a tapered end portion. The end of the stem 50 is recessed and sweated to the end of a portion of bared conductor emerging from the end of a section of cable to be joined. The whole stem portion, together with the bared conductor and cable end, 55 are embedded in a mass of "Polythene" which is closely moulded therearound

under pressure, the end face from which protrude the tapered portion and neck of the plug being moulded or trimmed flat, and the whole moulding comprising 60 embedded plug and cable end is moulded into a protective sleeve of metal as set forth in copending Application No. 7191 of 1941 (Serial No. 556,548), for effectively sealing the plug member thus 65 formed against ingress of moisture. The socket member of the coupling comprises a metal rod of substantially the same length as the plug accurately bored to a diameter slightly less than the 70 diameter of the plug, the length of the bore being rather more than is the combined length of the neck and tapered portion of the plug. Along the bored portion of the socket rod the wall is formed with 75 two or more saw cuts. Alternatively, the socket may be formed in two halves sweated together along the solid or stem portion, leaving the halves unsweated along the recessed portion forming the 80 socket proper. The end of the stem or unbored portion is recessed to receive the end of a bared portion of conductor emerging from the end of the other 85 section of cable to be joined by the coupling, and to which conductor the stem is sweated. The socket for the whole of its length, together with the attached conductor and cable end, are 90 embedded in a mass of "Polythene", 95 moulded under pressure into closely fitting engagement with the outside of the socket, a plug of diameter equal to that of the bore in the socket, being temporarily inserted in the bore during 100 moulding to prevent collapse of the split wall of the socket and removed subsequently. The face of the moulded mass is accurately moulded or trimmed flat and so as to be aligned with the end of the 105 socket, and the whole moulding comprising embedded socket and cable end is moulded into a protective metal sleeve in the manner set forth in the aforesaid copending Application No. 7191 of 1941 (Serial No. 556,548).

Dated the 22nd day of October, 1942.

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#### COMPLETE SPECIFICATION

#### Improvements in Electric Cable Couplings

We, ALEXANDER DALGETY FERGUSON, of San Isidro, Ashton Lane, Sale, in the County of Chester, a subject of the King

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subject of the King of Great Britain, and METROPOLITAN - VICKERS ELECTRICAL COMPANY, LIMITED, of Number One, Kingsway, London, W.C.2, a British 5 Company, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

10 This invention relates to plug and socket couplings, for connecting ends of cable, of the kind in which one or more metal pins or plugs partially embedded, together with a cable end or a conductor 15 or conductors emerging from the cable end, in moulded insulating material, is/are mated with a corresponding socket or sockets embedded with another cable end, or a conductor or conductors emerging 20 from the end thereof, also in moulded insulating material. Usually the pins or plugs of the plug member in such couplings have a rounded or tapered forward portion, for facilitating entry into 25 the co-operating socket of the socket member of the coupling, but in any case have a portion, or neck, of substantially right figure intended for making the desired electric contact with the forward end of 30 the surrounding wall of the socket.

In the case of such couplings intended for use in connecting together ends of cable required to carry ultra high frequency radio currents, it is especially 35 desirable, from the point of view of maintaining constant surge impedance at the coupling, that especially good contact should, at all times, be maintained between the neck of a plug and the forward end of the co-operating socket and that the insulating material surrounding the socket should at all times make intimate physical contact with the outer surface of the socket; the present invention 40 is especially concerned with the achievement of these desirable objects.

It is apparent in plug and socket couplings as hereinbefore set forth that, if the socket wall be constructed so as to 50 afford some degree of resilience, for instance by forming the socket with one or more saw-cuts or splits, and the socket is mated with an over size plug, relatively good electric contact is possible. However, difficulty then arises in the choice 55 of the mouldable insulating material in which the socket is to be embedded, since clearly the moulded material in which the socket is embedded must allow of the aforesaid flexing of the socket wall. In the case of couplings for use with ultra high frequency radio cable, it is not permissible to provide clearance between the outside of the socket and the 60 surrounding insulating material; on the

contrary, it is very important that the moulded insulating material should at all times be in close physical contact with the outer surface of the socket, and this, too, whatever be the conditions of temperature, if the coupling is to be satisfactory. 70

With the above considerations in view, according to the present invention the socket member of a plug and socket 75 coupling comprises one or more tubular parts having a bore conforming to the shape of, but somewhat less than the outside cross-section of, the plug pin or pins of the mating member of the coupling 80 which is/are intended to enter the socket(s) and having two or more slits in the wall thereof extending mainly in the axial direction of the socket, which socket or sockets is/are wholly embedded 85 in an insulating mass of "Polythene", moulded around, and into close physical contact with, the outside of the socket or sockets and preferably also the cable end or a conductor or conductors emerging 90 from the cable end.

"Polythene" is employed for the purpose in view in preference to the other more widely known and used mouldable insulating materials, by reason of its low 95 dielectric loss, great mechanical strength and especially good elasticity, even at temperatures up to tropical atmospheric temperatures as well as below freezing point; moreover it has a coefficient of 100 thermal expansion considerably greater than that of brass or other usual metal forming the socket or sockets, such coefficient for "Polythene" being in fact of the order of  $260 \times 10^{-6}$  per degree 105 Centigrade, as compared for example with a coefficient of  $80 \times 10^{-6}$  per degree Centigrade for one of the more usually employed mouldable insulating materials, namely vulcanite. 110

In addition to the fact that the mass of "Polythene" can be caused, by its excessive shrinkage, firmly to hold to the outside of the socket wall after moulding, yet be sufficiently resilient to follow 115 the flexing movement of the socket wall during repeated plugging in and out of the co-operating pin or pins, such close engagement between the embedding mass and the outside of the socket or 120 sockets can be maintained over an excessively wide range of temperature.

It is contemplated that during manufacture of the socket member of the coupling, a plug of the same cross-section 125 as that of the socket, or possibly slightly less, will be inserted temporarily within the hole in the socket so that the socket will not collapse under the moulding pressure as it otherwise might do by 130

reason of its resilient nature, and also to prevent, as far as possible, extrusion of "Polythene" into the hole in the socket. Usually entry of "Polythene" into the 5 slits or saw cuts in the socket wall will not be detrimental, since the high shrinkage of the "Polythene" will be sufficient to provide the necessary clearance from the bore of the socket.

10 It will be appreciated that the invention is equally applicable either to 15 couplings in which a single socket is mated with a single plug pin, or to couplings having two or more sockets 20 mating with respective plug pins, said plug pins, and correspondingly said sockets, being of any desired cross-sectional shape and being either all of the same shape or of respective shapes which

25 are different one from another.

In order that the invention may be fully understood an embodiment thereof will now be described, by way of example, with reference to the accompanying drawing, in which:—

Figure 1 shows in longitudinal section mating plug and socket members forming a cable coupling according to the invention,

30 Fig. 2 is an elevation, to enlarged scale, of a plug pin for the coupling shown in Fig. 1, while

35 Figs. 3a and 3b are respectively a longitudinal elevation and an end elevation of a socket for the coupling shown in Fig. 1, and

Fig. 4 shows in longitudinal elevation a modified form of socket.

The coupling shown in Fig. 1 comprises 40 a plug member 1 and a mating socket member 11 for coupling a length of concentric cable 2 to a length 12 of similar cable such for instance as for passing ultra high frequency current between 45 coupled parts of ultra high frequency electrical apparatus.

The plug member 1 in this embodiment has a single plug pin 4 comprising a cylindrical metal rod (Fig. 2) having a 50 relatively long stem portion 4a of fairly large diameter, for instance 0.2 inches in one practical application, a contiguous reduced portion or neck 4b accurately cut to right circular figure of a predetermined 55 diameter, and a tapered end portion 4c. The end of the stem portion 4a is recessed as indicated at 4d (Fig. 2) and sweated to the end of conductor 5 of the cable 2, from which the insulation 6 60 is stripped for part of its length as shown.

The whole stem portion 4a together with the bared conductor 5, and the end portion of the cable insulation 6 are 65 embedded in a mass of "Polythene"

indicated at 7 which material is closely moulded around the embedded parts under pressure. The end face of the moulded insulation from which protrude the tapered portion 4c and neck 4b of the 70 plug pin 4 is moulded or trimmed flat as shown.

The moulded insulation 7 and the end portion 6 of cable 2 are surrounded by a protective sleeve 8 having interior 75 grooves 8a and into which the insulation material is moulded, all as described and claimed *per se* in the specification of copending Application No. 7191 of 1941 (Serial No. 556,548), for effectively seal- 80 ing the plug member thus formed against ingress of moisture.

Since in this embodiment the cable 2 is provided with a lead sheath 9 and external wrapping 9a, the protective 85 sheath 8 is overlaid in part by the end portion of the lead sheath 9, and a moulding of "Polythene" indicated at 10, is provided around the overlaying portion of said sheath 9 and the adjacent portions 90 of the protective metal sheath 8 and outermost cable wrapping 9a, such moulding co-operating with external grooves 8b in the sheath 8, thereby to provide a moisture-proof sealing joint, all in the 95 manner set forth in the aforesaid Specification.

The socket of the mating socket member of the coupling with which the plug 4 is intended to co-operate comprises a 100 metal rod 14 of substantially the same length as the plug pin 4; this comprises a solid stem portion 14a and a portion 14b which is accurately bored to right circular figure of diameter slightly less than is 105 the diameter of the neck 4b of the plug pin 4, for a length which is rather more than is the combined length of the neck 4b and tapered portion 4c of the plug pin. Along the bored portion 14b of the socket, 110 the socket wall is formed with two or more axial saw-cuts 14c; in an alternative construction as illustrated in Fig. 4, the socket 14<sup>1</sup> is formed in two semi-cylindrical halves which are attached together, 115 as by sweating, for a portion of their length as indicated by broken line 14<sup>11</sup> leaving the two halves unattached for their remaining length 14<sup>111</sup>. The attached halves are recessed to provide 120 the right circular bore 14b<sup>1</sup> similar in other respects to the bore 14b for the socket 14 of Fig. 3a.

The end of the stem or unbored portion 14a of the socket is recessed as indicated at 14d to receive the end of a bared portion of conductor 15 emerging from the surrounding insulation 16 of the section of cable 12 which is to be joined through the coupling to the cable 2, the 130

conductor being attached to the socket stem as by sweating.

The socket 14 for the whole of its length, together with the attached conductor 15 and adjacent insulation 16 are embedded in a mass 17 of polythene moulded under pressure into closely fitting engagement with the outside of the socket 14; a plug of diameter equal to 10 that of the socket bore 14b will have been temporarily inserted in the bore during the moulding process in order to prevent collapse of the split wall of the socket.

The face of the moulded mass of 15 "Polythene" 17 is accurately moulded or trimmed flat in alignment with the end of the socket 14 so that this face may lie flat against the corresponding flat face of the plug member when the plug 4c, 4b is 20 entered into the socket 14b.

A protective metal sheath 18 surrounds the insulation moulding 17 and the cable insulation 16, said sheath 18 being provided with interior grooves 18a and the 25 insulation 17 being moulded into it, all in manner to provide a moisture-proof sealing joint in accordance with the aforesaid Specification. Since in the embodiment being considered the cable 12 is provided with a lead sheath 19 and outer cable wrapping 19a, the end of the sheath 19 emerging from the cable is caused to overlay a portion of the protective sheath 18; a moulding of "Polythene" 20 is 30 provided to enclose the end portion of the cable wrapping 19a, the overlaying portion of lead sheath 19 and the adjacent portion of the protective metal sheath 18, said metal sheath being provided with 35 exterior grooves 18b co-operating with the "Polythene" moulding 20 to afford a moisture-proof sealing joint in accordance with the aforesaid Specification.

Having now particularly described and 45 ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. For, or as part of, a plug and socket 50 cable coupling of the kind set forth, a socket member comprising one or more metal tubular parts forming a socket, or respective sockets, having a bore, or respective bores, conforming to the shape, 55 or respective shapes, but somewhat less than the outside cross-section, of the plug

pin or pins, as the case may be, of the mating plug member of the coupling which is/are intended to enter the socket or sockets, with each socket having two or 60 more slits in the wall thereof extending mainly in the axial direction of the socket and said socket or sockets being wholly embedded in an insulating mass of the material known as "Polythene", 65 moulded around, and into close physical contact with, the outside of the socket or sockets and preferably also the cable end or conductor or conductors emerging from the cable end. 70

2. For, or as part of, a cable coupling, a socket member according to the preceding claim, wherein the mass of "Polythene" in which the socket or sockets is/are embedded is moulded into a protective metal sheath formed interiorly with one or more grooves in accordance with the invention claimed in the Specification of Application No. 7191 of 75 1941 (Serial No. 556,548). 80

3. For, or as part of, a cable coupling, a socket member according to either preceding claim, in which the metal part or parts forming a socket, or respective sockets, comprises, or each comprises, a 85 stem having a cylindrical bore for part of its length which is slightly less in diameter than is the diameter of a right circular portion of a plug pin for the mating coupling member 90 which portion is intended to co-operate with the wall of the socket in establishing the electric contact, the wall of the bored part of the socket being formed with two or more, preferably axial, slots. 95

4. The modification of the cable coupling according to claim 3, wherein each socket is formed in two halves attached, as by welding, for a portion of their length other than that length forming the socket wall to receive the co-operating plug pin. 100

5. Cable couplings constructed as illustrated in the accompanying drawings and adapted for use as described with 105 reference thereto.

Dated the 3rd day of September, 1943.

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Agent for the Applicants.

*[This Drawing is a reproduction of the Original on a reduced scale.]*

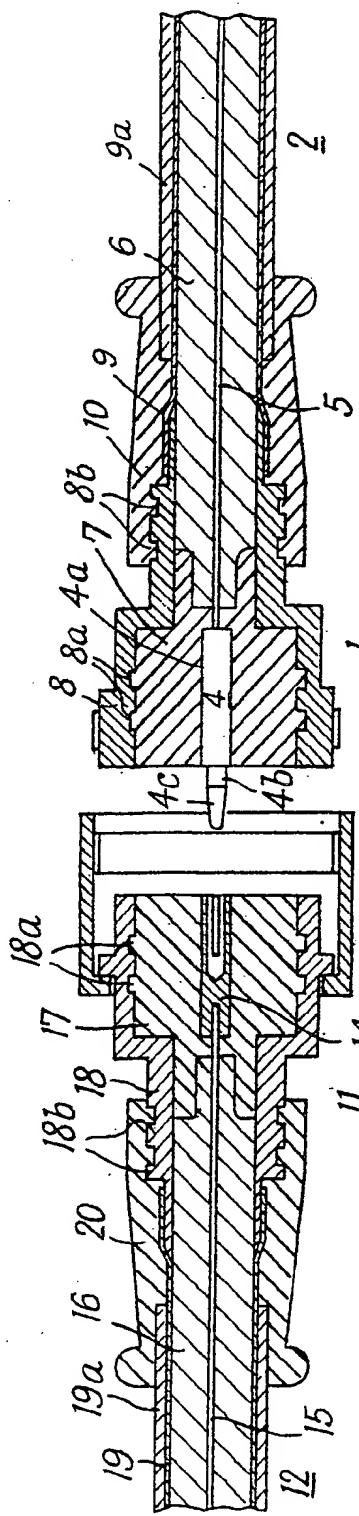


FIG. 1.

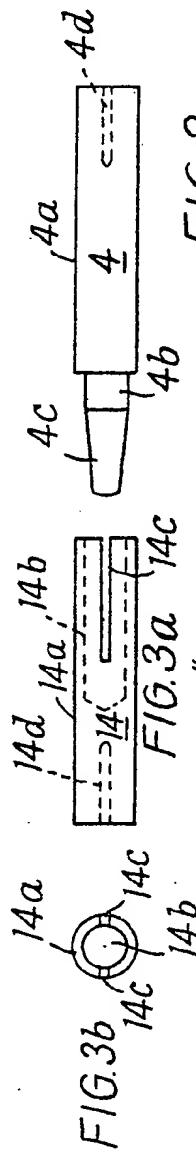


FIG. 2.

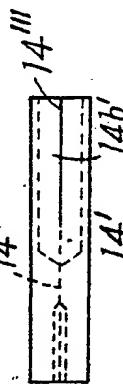


FIG. 3.



FIG. 4.